Standardisation Management in Electric Mobility

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Abstract

Interoperability technology standards became a significant factor in international trade with considerable economic importance and serve as valuable enablers of innovation. This holds particularly true for new areas of technology such as Electric Mobility. Standardisation and its management are embedded in a rapidly changing, competitive and complex global environment, influenced by national innovation policies. This paper first analyses the two different standard setting approaches of Europe and China, followed by a second part aiming to give an overview of the current state of the art in electric mobility standardisation management.

1 BACKGROUND

Nowadays, standard setting and standard management has fundamentally changed from being a narrowly 'technical' issue to an alignment of individual interests between the different players (Williams, 2009). One of the main reasons is the fact that interoperability technology standards have become a significant factor in international trade (Gibson, 2008) with considerable economic importance and serve as valuable enablers of innovation (Jakobs & Blind, 2010). At a time when globally implemented technologies such as advanced ICT technologies increasingly require compatible and harmonized standards to be fully effective, the role of standards is assuming increasing policy importance (Gibson, 2008).

Actually, for all stakeholders, the standard setting practice is subject to very different challenges. Firstly, standards making is characterized by an on-going and increasing convergence of IT systems and their global implementations, coupled with, and further accelerated, by the Internet. Hence, standard making processes are embedded in a rapidly changing and complex standardisation environment, driven by the growing importance of ICT and the globalization of markets and the respective national innovation policies executed on a regional level (Jakobs, 2010). Thirdly, the dynamics experienced, for example, in differences between sectors and technological fields. The alignment of interests of different players, the well-established ones and those who only recently have been entered the standardisation arena, cover not only standards development but also the implementation (Williams, 2009). Consequently, the outcomes of standards making often remain uncertain because they are subject to competing arrays of interests including driving and opposing forces (Williams,

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2009) - particularly regarding the different standardisation approaches in different regions such as Europe and China.

Electric mobility (e-mobility) is defined as electrification of mobility embedding Electrical Vehicles (EVs) in a wider urban mobility concept, including public transport and new usage models of private cars but also car sharing or leasing models, illustrated in figure 1. EVs are entirely or partially powered by electricity stored in batteries and were already invented end of 1800s. EVs are not just cars with a battery instead of a fuel tank. They require a charging infrastructure which cannot be created through fragmented efforts by e.g. vehicle manufacturers or energy companies. Batteries are a significant component besides the vehicle itself and the charging infrastructure necessary to re-charge the vehicle battery. It is assumed that in the area of batteries, new services and business models such as battery financing or battery charging will emerge.

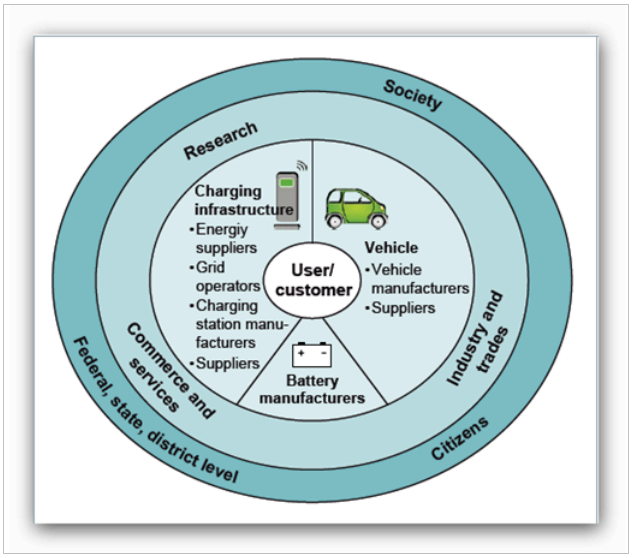

Fig. 1: The e-mobility environment (Source: German e-mobility Roadmap, 2010)

Until now, standards management in the electrical engineering/energy technology on the one hand and in the automotive technology domain on the other have been considered as separate entities. So far, there have only been very few attempts to look at them from a more integrated point of view. EV technology is less mature regarding the market than ICT in terms of the technology trajectory and that may lead to different dynamics of standardisation. However, standardisation of different interfaces of an EV is a central factor for a broad take-up of E-mobility. Against this background, the emerging question is whether Electro Mobility standardisation management in the respective countries and regions follows the same standardisation processes than ICT standardisation.

This paper is based on the findings of two research projects in the area of Chinese and European ICT Standards funded by the European Union (EU) and a Sino-German cooperation project in standardisation management. The paper is structured as follows. In the first part, the paper will analyse the different standardisation regimes in Europe and in China looking on different aspects from standard making to links between standardisation and R&D funding. The second part introduces a standardisation project in the field of e-mobility, focusing on current issues of MNEs in standardisation management and providing the ground for further research on looking on how standardisation impacts technological innovations in that area.

2 STANDARDISATION IN EUROPE AND IN CHINA – A BRIEF OVERVIEW

Today, the ICT standardisation landscape is still dominated by the US and the EU. This may soon change with the fast growing economy, and the subsequent influence, of transition countries such as India, Brazil and, most notably, the People's Republic of China (Jakobs, 2010). China has recently begun to be remarkably active in shaping interoperability standards as part of an effort to promote Chinese innovation capability and 'indigenous technologies' (Ernst, 2011). In the subsequent chapter, the focus is on the standardisation regimes of Europe and China, looking on different aspects from standard making to links between standardisation and R&D funding.

2.1 Differences in Standard making

There are three European Standards Organisations plus 30 National Bodies, and basically one central entity in China – the Standardisation Administration of China (SAC). In several respects, the European approach differs. For one, it is not so much centralised. Also, the European Commission (EC) issues mandates to the ESOs to produce European Standards (which the ESOs are free to decline; this rarely ever happens, though). But also beyond that the EC does pro-actively influence standardisation (CEU, 2008). Under the 'New Approach' to standardisation the essential requirements" are defined in 'Directives'; the ESOs are then charged with developing the Harmonised European Standards that specify how to meet them.

Also, not all standards are equal. European standards, while still strictly voluntary in nature, clearly enjoy priority (CEU, 1985). Moreover, unlike in the US, the EU has a clear preference for European standards, e.g., in public procurement (CEU, 1985). Obviously, companies that wish to do business in EU countries may consider the application of European standards not one hundred percent voluntary in practice. Last, but certainly not least, the EC does have an influence over the ESOs. This may primarily be attributed to the fact that a significant percentage of the ESOs' funding comes from the EC Rules for cooperation between the individual ESOs on the one hand, and between ESOs and national bodies on the other have been established. As a result, neither are European standards in conflict with each other, nor are national standards in conflict with European ones.

China's acceptance into the WTO in 2001 led to an overhaul to its national standards structure, according to the compliance requirements of the WTO agreement on Technical Barriers to Trade (TBT). In this context, China has formulated new development strategies and concepts. These strategies are focused on technical standards which are expected to be an important means by which China's national development goals are attained. They are seen as a bridge to translate research achievements into productive forces, guide the development of the high-tech sector (especially in IT) (Zhao & Graham, 2006). In order to meet the WTO 2001 requirements, China was required to reform its national standard system. To meet these requirements, China consolidated two institutions with overlapping authority—the State Administration for Entry-Exit Inspection and Quarantine (CIQ) and the State Quality and Technical Supervision Bureau (QTSB)—to form the General Administration for Quality Supervision Inspection and Quarantine (AQSIQ). In April 2001, AQSIQ formed the Standardisation Administration of China (SAC), the body currently charged with establishing and overseeing national standards in China. SAC is charged with the drafting and revision of state laws and regulations as well as the formulation and implementation of relevant policy SAC also oversees the creation of development programs concerning national standards in China and provides organizational and coordinative oversight. As a developing national standard nears completion, SAC is also responsible for the examination, revision, approval, and subsequent publication of the standard (Zhao & Graham, 2006). SAC has sole

responsibility for the dissemination, implementation, and popularization of national standards. Two of the more prominent arms of SAC are the National Technical Committee on Standardisation (TC), which deals with technical fields, and the China National Institute of Standardisation (CNIS). Whereas the TC has to deal with national standardisation involving technical fields, as the largest national standards research body, the China National Institute of Standardisation (CNIS) is directly subordinate to AQSIQ and supports SAC, the Ministry of Science and Technology (MoST), and other ministries. Besides the CNIS, the 16 ministries preside over 26 additional trade standardisation research institutes; for example, the China Electronic Standardisation Institute (CESI) (Zhao & Graham, 2006). The China Association for Standardisation (CAS), a state-level standardisation association directly subordinate to AQSIQ, promotes standards to industry and enterprises and includes 7 professional branches for standardisation, as well as 4 secretariats.

2.2 Standards emergence

Traditionally, the European system did not follow a sector-based approach; rather, the three ESOs mirror the structure of the international standardisation system. However, a more 'sectoral' element has been introduced through the increasing proliferation of 'lightweight' deliverables (e.g., CEN Workshop Agreements). New activities are launched either through 'Mandates' (issued by the EC; to meet regulatory needs), or though 'bottom-up' initiatives by member organisations (to meet technical/market needs).

China's standards system has adopted characteristics of both the US and the EU system. The more structured, centralised approach, under some influence by government entities, resembles the European one. On the other hand, the Chinese system shows a considerable degree of sector-orientation. In contrast to the more market-oriented systems in the EU and specifically in the US, in China standards a requested by the government and not required by the industry (Rongping & Zhuoliang, 2005). As a member of WTO, China is expected to try to harmonize national standards with international standards. Standards and quality infrastructure development should apply the basic principles the WTO Agreement on Technical Barriers to Trade (TBT) that recommends; i.e.: transparency, openness, consensus building, effectiveness and balanced participation of stakeholders, including environmental and consumer interests.

2.3 Types of standards

The ESOs only develop standards whose implementation and use are voluntary (as opposed to compulsory standards). In practice, however, there are certain limitations to the 'voluntariness' especially of Harmonised Standards (i.e., those European Standards that were adopted following a mandate issued by the European Commission). Compliance with Harmonised Standards provides presumption of conformity to the corresponding essential requirements of the referencing EC directive(s). These days, ESOs produce a variety of deliverables, many of which do not have to go through the full open and consensus-based process that leads to European standards. The NSOs continue to produce national standards.

According to the Standardisation Law of the People's Republic of China (1989), standards are divided into four levels: national, trade, local and enterprise standards. Standards can be categorized hierarchically both by levels of responsibility and by whether the standards are voluntary or mandatory. National standards—both mandatory and voluntary—are at the top of the hierarchy and are the responsibility of the Standardisation Administration of China (SAC).

SAC, which has Vice ministerial status, is part of the Chinese General Administration of Quality Supervision Inspection and Quarantine (AQSIQ). SAC serves as China's "national body" at most international standards organizations (such as the ISO and IEC) 24 and oversees the administration of the national standards. By the end of 2004 China had some 21,342 national standards, of which 3,045 were compulsory. These compulsory standards include regulations for processes and products, accounting, hygiene and safety, and environmental protection. The next levels are industry or trade standards. Trade standards meet the needs of industries for which no national standard exist, but which still require standardisation (Zhao & Graham, 2006). By 2004 more than 37,850 industry standards had been registered with SAC (Suttmeier et. al, 2006). In the absence of both national and trade standards and where safety and sanitation requirements for industrial goods require local unification, on the third level local standards are used. By 2004 some 15,800 local standards had been registered with SAC. (Zhao & Graham, 2006).

Enterprise standards are representing the fourth and last level of Chinese standards. According to standardisation experts, more than 100,000 sectoral and industry standards are in place of which only around 20% are actively used. In addition to the governmental and industry organizations noted above, the operation of the standards system also involves some 264 technical committees and 386 subcommittees involving some 30,000 technical experts. The standards system also includes the work of more than 25 standardisation research institutes at the national level and 158 local institutes including the Shanghai Institute of Standardisation (SIS) and the Shenzhen Institute of Standards and Technology (SIST). (Suttmeier et. al, 2006). From national to local level, there exists an array of institutions with responsibilities ranging from the drafting of documents and promulgation of standards to technical oversight and the research on standards-related issues.

2.4 Stakeholder representation

In terms of members, ETSI closely resembles the US SDOs with a membership base primarily made up of companies (with a relative majority of manufacturers), government entities, research organisations, and users. In contrast, the National Standards Organisations (NSOs) are the only members of CEN and CENELEC. Membership in an NSO, in turn, is open to all interested parties. However, participation by government agencies, users, and consumer representatives is typically comparably low. In ETSI, members are supposed to act as company representatives. CEN and CENELEC stipulate that they act in purely personal capacity (i.e., neither as corporate nor national delegates).

Chinese standards are developed by of government employees, for example researchers from universities and public research institutes whereas the roles of trade associations and enterprises are marginal (Rongping & Zhuoliang).

2.5 Integration of standards consortia

In Europe, for decades, the prevailing stance had been to doubt industrial for and consortia standardisation work (CEU, 2004). Rather than referring to consortium standards, ESOs' 'New Deliverables' are referenced in legal documents (CEU, 2004). This is done despite the facts that new Deliverables (such as, for example, CEN Workshop Agreements) only require a very low level of consensus, and are not necessarily subject to a public enquiry, and many consortia have implemented processes that are much more rigid. Recently, however, and following a study on the EU's future ICT standardisation policy, first signs of a change of mind could be observed (CEU, 2011). China seems to show a preference for working through established, institutionalized standards organizations, more in keeping with European and

Japanese practices (Suttmeier et. al, 2006). This is little surprise, given the extremely centralised and co-ordinated Chinese national standards system. Consortia also do not play a role in the Chinese standardisation law.

Today, the Chinese government is also beginning to place increasing attention upon product quality and safety standards and the enhancement of consumer rights. As far as China is concerned, Chinese decision makers have turned their attention to standards as part of a strategy for meeting new competitive challenges and obligations resulting from China's accession to the WTO. Ten years ago, China has started to integrate standard setting into its national research and development programs as a priority objective (Suttmeier & Xiangkui, 2004). According to the authors, the new interest in standards also grows out of the ambiguous position of China in the international economy and the ways in which its technological levels affect that position. On one hand, the Chinese economy benefited significantly as a result of its participation in the international production networks associated with globalization. China has become one of the world's great exporters producing and exporting high value products. However, most of the technologies used in production are based on foreign technologies where China has no control over standards and intellectual property and Chinese companies pay a large amount of royalty fees. Therefore, by the year 2020, China wants to become an "innovation-oriented society". The central objective of the Chinese technology policy is the development of products incorporating Chinese intellectual property and employing Chinese developed standards, the so-called "indigenous innovation".

3 SINO-EUROPEAN COOPERATION IN EV STANDARDISATION MANAGEMENT

In the light of becoming an inventive country with leading technologies, Chinese leaders have adopted a plan aimed at turning the country into one of the leading producers of hybrid and all-EVs within the next years, and to subsequently make it the world leader in electric cars and buses. China's intention, in addition to creating a world-leading industry that will produce jobs and exports, is to reduce urban pollution and decrease its dependence on oil. This chapter seeks to provide an overview of the current situation of EV standardisation and related challenges with a particular focus of how the industry attempts to implement an effective standardisation management in an international environment. The project is one of the agreed cooperation projects between China and Germany in e-mobility standardisation management. The objective of the project is to get all relevant stakeholders involved in the necessary standardisation activities in order to understand the different requirements and to build up an overall infrastructure enabling frictionless e-mobility. The idea behind is to implement joint Sino-European research between Chinese governmental institutions and the European stakeholders involved in e-mobility such as automotive manufacturers, the electric-electronics industry and battery suppliers.

3.1 Electric Vehicle Standardisation approaches – EU and China

The European strategy on clean and efficient vehicles has been adopted in May 2010 as part of the European response to the financial/economic crisis of 2008/2009. It provides a public policy framework for the support to the development of alternative technologies in the automotive sector. Green technologies play a central role in the sustainable development in Europe. The Strategy defends a two-tracks approach, assuring technology neutrality: Firstly, the promotion of technologically advanced and fuel efficient vehicles to be put on the market in near future with a focus on the combustion engine (2020 perspective), increased use of sustainable bio-fuels, and gaseous fuels. The European road map and the action plan for

promoting and facilitating the emergence and proliferation of breakthrough technologies is mainly focused on Electric Vehicles (plug-in hybrids and fully electric) and Hydrogen-powered vehicles. A main element preparing the Electric Vehicle market is Electric Vehicle standardisation attempting to aim for global harmonization reflected in figure 2.

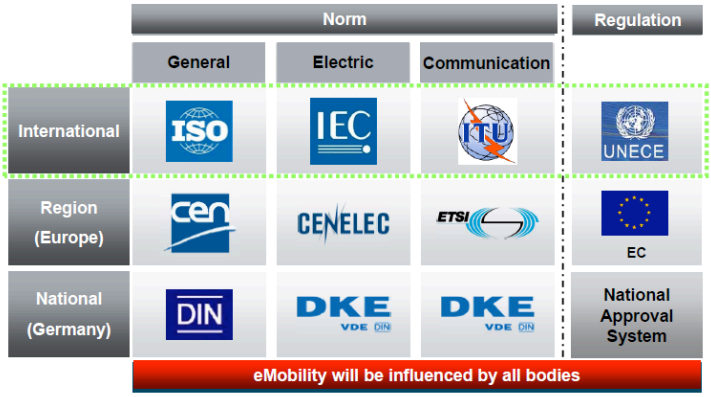

Fig. 2: The EV standardisation landscape (Source: German e-mobility Roadmap, 2010)

China's Electric Vehicle standardisation strategy is part of the 12th five-year plan and aims to establish a scientific, systematic, open, orderly and adjustable renewable energy vehicle standard system which meets fully research, industrialization, commercialization and management and become an important technical support for the Electric Vehicle industry. The idea behind this is to transform the large number of latest achievements and advanced experiences into these standards and subsequently publish these standards and get involved in international standard activities. China's standards development attempts to transform from a standard follower to a standard leader. The technical route of standards development will be transformed from research to a combination of joint research and industrialization. The work emphasis of the standards development will be on the coordination of enterprise, industry and national standards. The figure below illustrates the EV standardisation organisation.

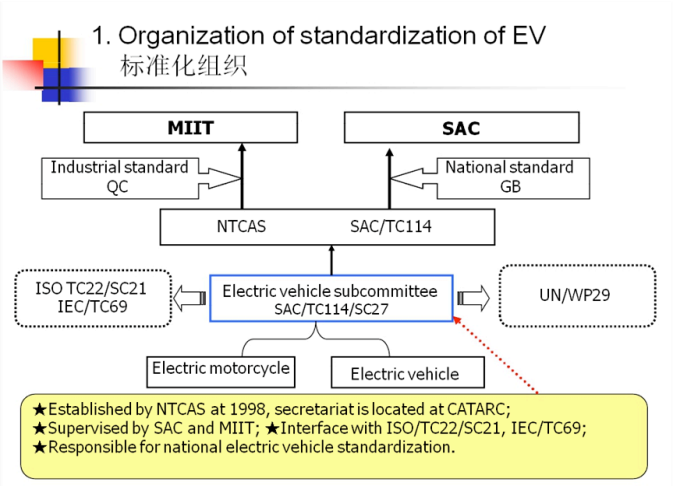

Figure 3: Electric Vehicle Standardisation organization in China

In total, 57 standards have been published since the Ninth Five Years Plan (12 standards for Electric Vehicles, 8 for HEV, 7 for FCEV, 6 for e-motorcycles, 8 for energy storage, 5 for Electric motor and 11 for infrastructure). Currently, 7 standards passed the examination by SC27 waiting for approval, 19 new standards are under development and 45 standards are under preliminary research. Since the first standards of Electric Vehicle have been released in 2001, they became the basis and the technical support for project application and evaluation, such as the State 863 program as well as technically supported the Electric Vehicle technology innovations. The "Renewable energy automotive manufacture and product access management" released by the Ministry of Industry and Information Technology (MIIT), June 2009, describes that Electric Vehicles must meet the existing conventional test items and specific standards. Electric Vehicle standards play an import role in the Electric Vehicle industry, manufacturing, or product access. 26 Electric Vehicle specific testing standards including national and industry standards were drafted by the Electric Vehicle technical subcommittee of NTCAS.

3.2 Electric Vehicle Standardisation Management

As outlined before, standardisation is one of the central aspects if the introduction of EVs in the market should gain acceptance. For both participating countries, and the respective industry and governmental organizations, the challenge will be to justify to which extent the corporate stakeholders, for example international automotive manufacturers or power suppliers, are able to cooperate and jointly follow procedures existing in the respective countries. From a stakeholder perspective involved in e-mobility standardisation management, it is observed that a number of requirements are important with regard to EV standards. First of all, international corporations rather aim for international standards than national companies do in order to save money for R&D, as well as for other cost; for example later in large scale production, and in the e-mobility environment, most notably to save market access time. Actually, national and international standardisation concepts are competing. Although standardisation on a national level is much quicker, at least in China, it is considered by international corporations to be inadequate on an international level being present in global markets. However, due to the fact of the different stakeholders and interests involved, collaboration and coordination amongst all relevant parties turns out to be a challenge.

Second, international corporations favour the approach that existing standards have to be used and further developed. There are already a number of standards existing in the automotive technology and electrical engineering sectors that could be used and further developed. According the international corporations, they recognize that unfortunately, in some countries the tendency is observed to set own standards in order to gain a market advantage in their own market. Again, the identified opportunities to benefit from already existing local standards, turns out to be challenged at the beginning of this project. Nevertheless, some technical solutions need to be defined in interface standards to ensure interoperability (e.g. between vehicles and the network infrastructure). Due to the existing different standard setting approaches of the regions mentioned, companies often have to face not only the ambiguity of standards developed but also have to deal with very strict technical specifications like for example, the standardisation of battery dimensions.

Third, one of the most urgent standardisation issues to solve in the e-mobility arena is a worldwide charging infrastructure to ensure interoperability. Currently a number of standardisation projects on national and internationally are carried out, for example in the areas for charging EVs. The relevant system components of an EV are shown in figure 4. Besides communications/energy flows and vehicle engineering, the charging infrastructure is

requiring standards to ensure interoperability between the different components. Functional safety and electrical safety are both cross-cutting topics affecting all system components.

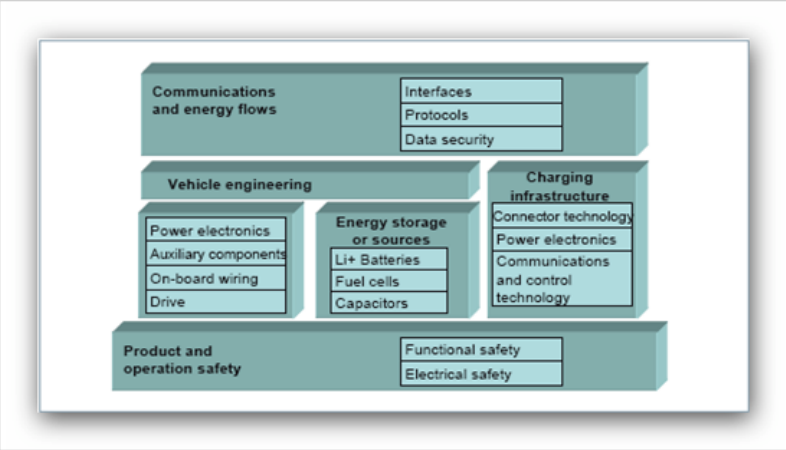

Fig. 4: ICT in EVs (Source: German e-mobility Roadmap, 2010)

Charging electric vehicles "everywhere, at all times" is a MUST to gain market acceptance by consumers. Interoperability of vehicles with infrastructure provided by various operators has to be ensured and the standardisation of charging techniques and billing/payment systems has to be user-oriented, uniform, safe and easy-to-operate. Charging infrastructure is the area of an EV with the strongest link to ICT standards and standards management. It is understood by all stakeholders that a charging infrastructure has to be internationally standardized in order to succeed in the commercial auto market. Practically all automotive manufacturers are about to bringing their ready EVs on the market which consequently will impose some pressure on the electrical networks everywhere. Hence, this will definitely impact the management of electricity grids, for example in increasing peak loads or ensuring a sustainable supply of electricity. In the area of charging infrastructure for example, there are currently four players, Europe, US, Japan, and China.

Particularly China where electric vehicles have been very high on the innovation agenda for more than 20 years has been remarkably active in the charging standardisation field. However, in terms of testing procedures which are required for type approval of cars in the respective markets, there is still a gap to fill in. The elements to be standardized are charging poles, wall boxes (or home-chargers), cables and plugs. Currently, there is no existing global set of standards for the charging infrastructure dedicated to electric vehicles. Thus, current market access regulations are based on a combination of existing standards for vehicles in general with some specific EV requirements and reliance on automotive manufacturers' own testing specifications. Since it is unclear what regulations and standards shall be applied, the ground for any meaningful and comprehensive certification scheme is not yet in place which means for an automotive international corporations that if it intends to sell an EV in China, there is no type approval available with a specific focus on charging.

From a strategy point of view, European international corporations involved in E-mobility in China are facing these types of issues and have started to act in different ways regarding the management of standardisation. The headquarters of big corporations have set-up special standardisation departments assigning them with special mandates for particular regions in order to ensure to fully cooperate with local governments and understand the rules and regulations. With regard to the implementation of this concept, usually, employees from the headquarters frequently travel to different regions supported by local staff being based in the

respective country. Smaller companies that often cannot set-up a dedicated standardisation team are mostly also present in the different regions and closely linked with the international corporations. In China for example, the European industry stakeholders involved in EV standardisation build alliances to join forces, e.g. draft and present common position papers that are handed over to governmental organizations, e.g. embassies, in order to express common standardisation strategies and concepts for future implementation. This is also supported by organizing cross-company workshops to informing and educating suppliers and other interested parties in international standards, e.g. in ISO/IEC standards used in Europe. In addition, a very tight cross-company information exchange is established. The EV representatives of different companies know each other and exchange information on a regular basis and maintain very good personal relationships.

4 CONCLUSION

The concept of e-mobility and EVs will be a major field of innovation throughout the coming decades. Ensuring sustainable mobility is one of the prerequisites for economic growth, and transport and automotive industries are still major industrial sectors of enormous relevance for example in Europe and in China. Hence, standardisation management is characterized by several features distinguishing it from previous standardisation processes. In E-Mobility, the challenge is to coordinate and integrate diverse activities in different sectors in order to effectively meet demands. E-Mobility is a radical innovation that requires a new, cross-sector systems thinking. However, regarding standardisation in general, initially, the EV standardisation process in the regions analysed, is in line with the national approaches of standardisation. Not until the later stage of implementation, stakeholders, particularly international corporations recognise the differences and subsequently try to influence the trajectory of technology and with that the broader process of standardisation management; for example regarding important e-vehicle components such as batteries.

Taking up a stance on standardisation, one has to notice that it has gradually become a strategic instrument, particularly in new areas of technology such as the e-mobility field. For the stakeholders involved, particularly for the industry, the e-mobility standardisation management for developing and implementing standards are a tough and challenging matter to deal with on an international level. Some of the technology is still not very mature and in the area of charging huge infrastructural investments have to be made in future. It is expected to see the emergence of new business relationships and business models offering value added services. New service configurations, such as in the battery field require standards to ensure the necessary interoperability for re-charging. Further research will be carried out to analyse for example how stakeholders such as grid operators or manufacturers of the charging stations will influence EV standardisation management.

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